ANNEX 1

Energy Outlook Results of the Association of Southeast Asian Nations

Alloysius Joko Purwanto

This chapter should be cited as:
Purwanto, A.J. (2023), 'Energy Outlook Results of the Association of Southeast Asian Nations ', in Kimura, S., H. Phoumin, and A.J. Purwanto(eds.), *Energy Outlook and Energy-Saving Potential in East Asia 2023*. Jakarta: ERIA, pp.401-424

1. Background

According to the World Bank World Development Indicators database (The World Bank, 2023), the 10 member states of the Association of Southeast Asian Nations (ASEAN) reached a total gross domestic product (GDP) of around $3.06 trillion in 2021.[1] During the period of mobility restrictions imposed by the coronavirus (COVID-19) pandemic the region, like other parts of the world, witnessed a growth of 3.2% compared to the total GDP of approximately $2.96 trillion in 2021. Due to the pandemic the total GDP decreased by 3.62% from the 2019 GDP of $3.08 trillion. Before the pandemic, the growth rates were 4.48% for 2018¬–2019 and 5.21% for 2017–2018.

By 2021, Southeast Asia was then the world's 5th largest economy, only behind the United States ($20.53 trillion), China ($15.80 trillion), Japan ($4.43 trillion), and Germany ($3.56 trillion). The International Monetary Fund (2022) estimated that ASEAN-5 countries (Indonesia, Malaysia, Philippines, Singapore, and Thailand), GDP growth rates would increase to 5.0% for 2021–2022, 4.7% for 2022–2023, and 5.1% for 2023–2024.

The total GDP of the 10 ASEAN member states is projected to rise from around $3.04 trillion in 2019 to around $10.49 trillion in 2050, which is an average annual growth rate (AAGR) of around 4.1%. At the same time, the total ASEAN population will increase with an AAGR of 0.8%, from around 661 million in 2019 to around 841 million in 2050. Further, GDP per capita is projected to increase from around $4,606 in 2019 to $12,471 in 2050, an AAGR of around 3.3%.

In this chapter, we present the energy outlook for the aggregated results of ASEAN members. We begin by discussing the results of business-as-usual (BAU), followed by the results of the outcomes of the fifth alternative policy scenario (APS). The APS focuses on enhancing energy efficiency and conservation (EEC) amongst end users, as well as expanding the use of renewable energy sources. Finally, we examine the outlook results of the low carbon energy transition scenario (LCET). In the LCET, ASEAN members aim to achieve their respective carbon neutrality targets by the 2050 or 2060 (depending on the country). This will be accomplished through the implementation of low-carbon technologies such as carbon capture utilisation and storage (CCUS) and/or carbon capture and sequestration (CCS), as well as the adoption of new energy sources and carriers, such as hydrogen and ammonia in conjunction with gas-fired and coal-fired power plants.

The LCET scenario includes fuel switching from fossil fuels to hydrogen, electricity, and biomass in transport and industry activities, as well as the application of CCUS/CCS in industry production and power generation. In the LCET scenario, fuel switching from coal to highly efficient combined cycle gas turbine (CCGT) is considered a transitional pathway. From 2035 to 2050, hydrogen will not only replace coal in iron and steel production but also diesel in other activities, reaching a 100% utilisation rate. The application of hydrogen and ammonia, including co-firing in power generation and boilers in industry, will be implemented after 2040. Biomass will also be used to replace coal and natural gas various activities, with the timing and utilisation

[1] This report uses constant 2015 United States dollars.

rate varying by country, with some countries starting as early as 2030 and reaching up to 95% utilisation rate of up to 95% by 2050. Finally, electricity will replace and diesel in public transport, with some countries expected to adopt electric buses by 2035. Electric vehicles will also be introduced in private transport gradually replacing diesel and gasoline from 2025 to 2050, with a maximum utilisation rate of 70% depending on each country's situation.

In both the APS and LCET scenario, we show the progress of final energy demand, primary energy supply, power generation sector, and several energy indicators that reflect the region's advancements in improved energy, reduced energy intensity, and carbon emissions.

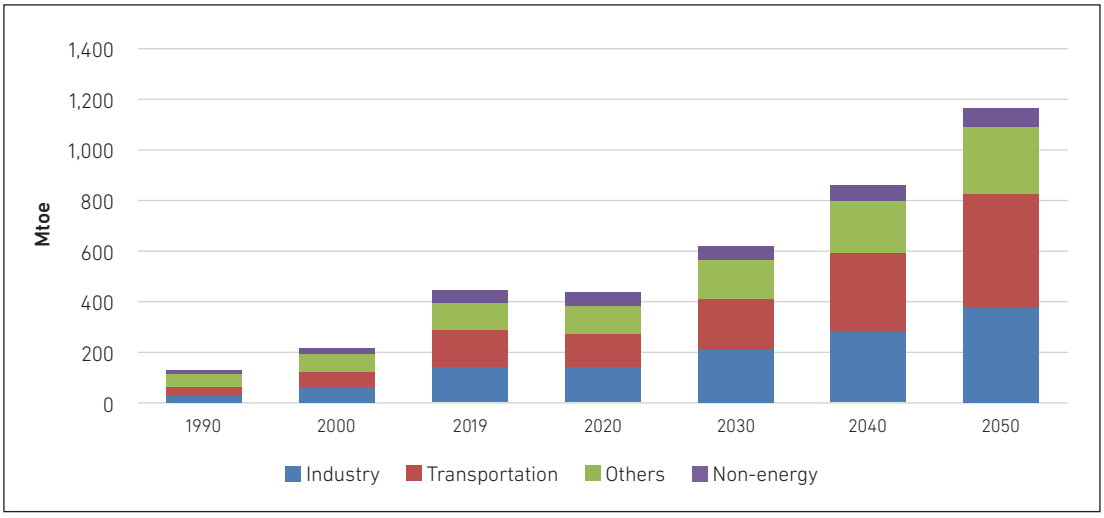
2. Outlook Results

2.1. Business-As-Usual

2.1.1. Final Energy Demand

ASEANS's final energy demand grew at an annual rate of 4.3% from 130 million tonnes of oil equivalent (Mtoe) in 1990 to 448 Mtoe in 2019. During this period, the 'others' sector (residential and commercial) dominated energy consumption, increasing from 53 Mtoe in 1990 to 108 Mtoe in 2019, with an AAGR of 2.5%. This transport sector followed with an AAGR of around 5.4%, and the industry sector with an AAGR of 5.0%. In 2019, the industry sector accounted for the largest share of energy consumption at around 150 Mtoe (34%), followed closely by the 'others' sector at 142 Mtoe (32%), and the 'others' sector at 108 Mtoe (24%). Around 11% of the region's total energy in 2019 was used for non-energy purposes, especially as feedstock for petrochemical production.

Figure A.1 Final Energy Demand by Sector, Business-As-Usual, 1990–2050
(Mtoe)



Mtoe = million tonnes of oil equivalent.

Note: 'Others' covers subsectors such as residential, agriculture, services, and commerce.

Source: Author's compilation.

Under BAU, final energy demand is projected to grow by 3.1% per year from 2019 to 2050. The fastest AAGR is expected to occur in the transport sector (3.8%), whilst the industry will grow at 3.0% and the 'others' sectors at 2.9%. Demand is projected to grow at an AAGR of 1.4% in the non-energy sectors. The slow growth in the 'others' sector will be caused by the shift from traditional biomass use, especially in the residential sector, to other commercial and more efficient energy sources, such as oil and electricity.

Transport will account for the highest share of total final energy demand in ASEAN, followed by the industry sector and the 'others' sector. By 2050, the transportation sector's share of energy use is expected to reach nearly 39%, while that of industry is projected to reach 33% and that of the 'others' sector nearly 23%.

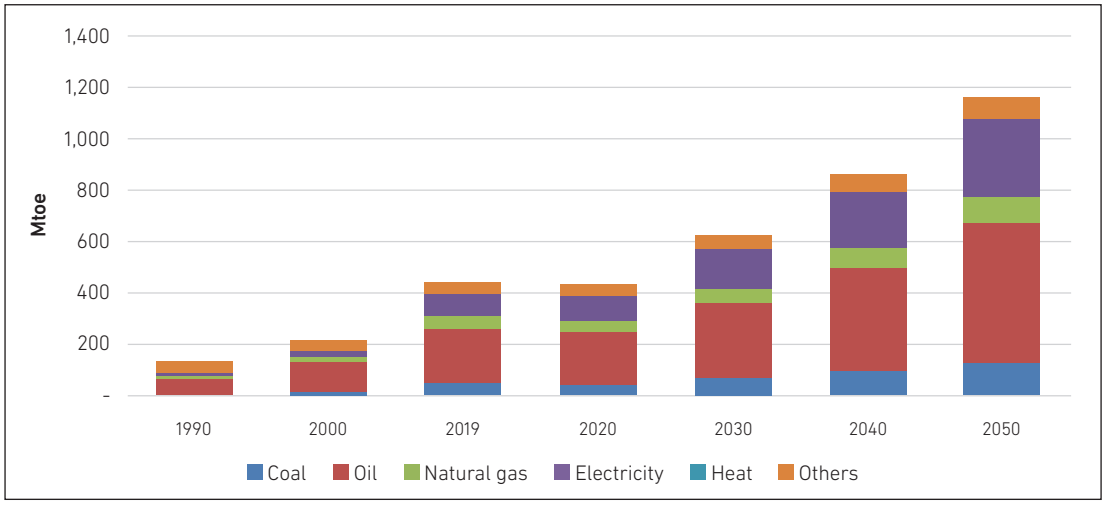
By fuel type, coal experienced the fastest growth from 1990 to 2019, at an AAGR of 8.6%, mainly driven by the rapidly expanding industry sector. In the same period, electricity grew by 7.6% per year and natural gas by 5.0%. Demand for oil grew by 4.2% per year, while demand for 'other' sources, mostly traditional biomass, grew by 0.7% per year.

Oil held the largest fuel share with 63.37 Mtoe (49% share) in 1990. By 2019, its share only slightly decreased to 47% (210 Mtoe). In 2019, oil remained the primary fuel , with the highest share, followed by electricity (21%), coal (12%), others (11%), and natural gas (10%).

Under BAU, the demand for all fuels between 2019 and 2050 expands, but at a slower AAGR. Electricity will grow the fastest at 4.0% per year, followed by oil and coal (each at around 3.0%), natural gas (2.5%), and others (2%).

With a share of around 47% in 2050, oil is still expected to play a major role in ASEAN's final energy demand. From 1990 to 2019, the share of oil increased from 40% to around 45%. Under BAU, oil's share of the final energy demand is expected to remain constant at around 46%–47% during 2020–2050. Meanwhile, the share of electricity in the final energy demand will increase to around 21% starting in 2020, before it rises further to 26.5% by 2050. Figure A.2 shows the final energy demand by fuel.

Figure A.2 Final Energy Demand by Fuel, Business-As-Usual, 1990–2050
(Mtoe)



Mtoe = million tonnes of oil equivalent.

Note: 'Others' covers solid and liquid biofuels.

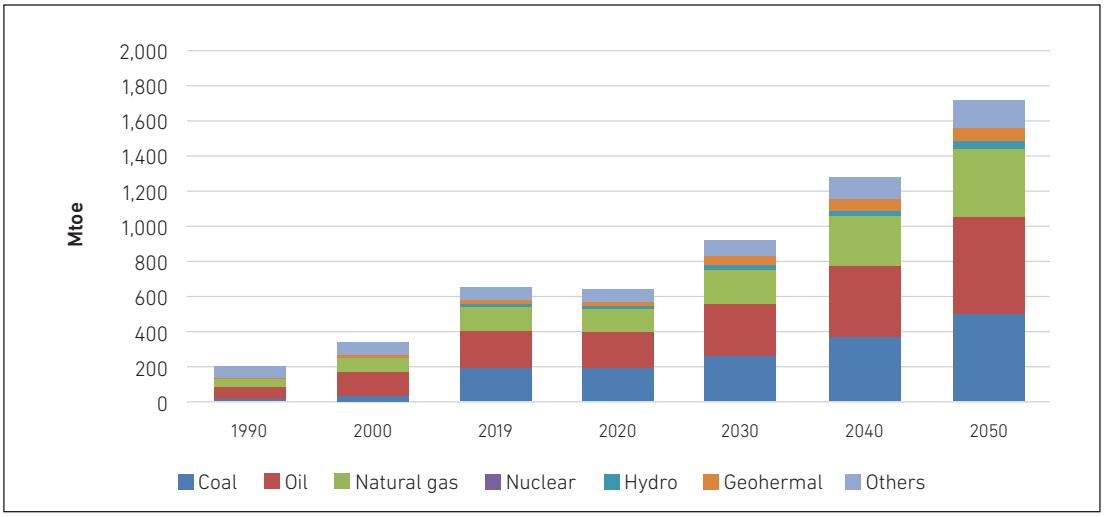
Source: Author's compilation.

2.1.2. Primary Energy Supply

Total primary energy supply grew by 4.0% per year, from 211 Mtoe in 1990 to 661 Mtoe in 2019. The ASEAN region's dominant source of energy in 1990 was oil, which accounted for almost 38% of the total primary energy supply (TPES); and oil consumption increased from nearly 80 Mtoe in 1990 to 218.5 Mtoe in 2019, an AAGR of 3.5%. The second dominant source of commercial energy in 1990 was "Others" (sources of energy) mostly composed of traditional biomass. Consumption of traditional biomass decreased from nearly 71 Mtoe in 1990 (34% of the TPES) to 62 Mtoe in 2019 (12% of the TPES), an AAGR of -0.4%. The fastest growing energy source is coal, the consumption of which increased from 13 Mtoe in 1990 to 192 Mtoe in 2019, an AAGR of 9.9%. This fast growth rate of coal consumption was followed in the second place by hydropower consumption that increased at an AAGR of 6.6% and geothermal at an AAGR of 4.7% during 2019–2020.

As shown in Figure A.3, total primary energy supply under BAU is projected to grow by 3.1% per year between 2019 and 2050. Of the energy sources, solar, wind, solid, and liquid biofuels altogether are expected to grow the fastest at 6.1% per year, followed by biofuels at 5.3% and geothermal at 4.5%. Natural gas is expected to increase at an AAGR of 3.5%, followed by coal at an AAGR of 3.2%, oil (3.0%) and hydropower (2.5%). By 2050, oil is expected to be the dominant energy source, accounting for around 32% of the TPES, followed by coal with 29% and natural gas with 22.5%. Hydropower's share is expected to remain limited to 2%, whilst geothermal' s share will reach almost 5%. 'Others' (energy sources) will account for around 9% by 2050 as this share is expected to grow by 2.2% during 2019–2050.

Figure A.3 Primary Energy Supply, Business-As-Usual, 1990–2050
(Mtoe)



Hydro = hydropower, Mtoe = million tonnes of oil equivalent.

Note: 'Others' covers solar, wind, and solid and liquid biofuels.

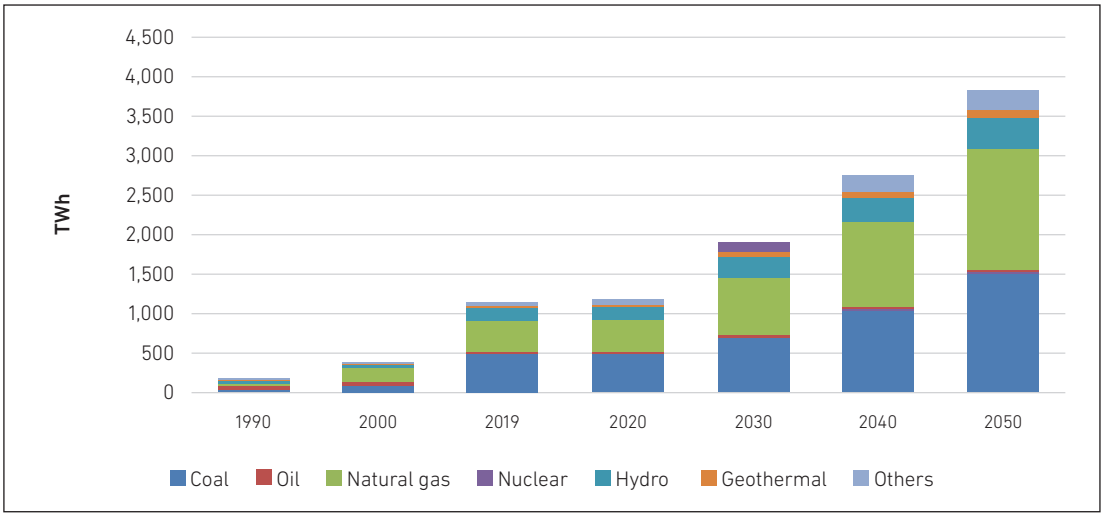
Source: Author's compilation.

2.1.3. Power Generation

Electricity generation grew by 7.1% per year from 155 TWh in 1990 to 1143 TWh in 2019. The power generation mix has changed significantly since 1990, with a shift from oil to natural gas and coal. In 1990, natural gas and coal accounted for 18% each, around 28.5 TWh and 28 TWh, respectively of electricity generation in ASEAN. However, in 2019, natural gas supplied 34% (403 TWh) of the region's electricity and coal supplied 43% (493 TWh). Hydropower's share dropped from 18% (28 Mtoe) in 1990 to 14.5% (166 TWh) in 2019, while the fuel oil's share for thermal power generation dropped from 41% (63.5 TWh) in 1990 to only 2% (19 TWh) in 2017. Other energy sources, including biomass and solar, accounted for only a small proportion of the mix, increasing from nearly zero in 1990 to around 4.5% in 2019.

Under BAU, power generation is projected to increase at 4% per year from 2019 to 2050, reaching 3,832 TWh (Figure A.4). Natural gas is expected to have the largest share of the power generation mix, with 41% of the total energy output in power generation by 2050, followed by coal (40%) and hydropower (10%). Generation from other energy sources, comprising of biomass and solar power, will see the fastest growth at an AAGR of almost 5.5%.

Figure A.4 Electricity Generation, Business-As-Usual, 1990–2050
(TWh)



Hydro = hydropower, TWh = terawatt-hour.

Note: 'Others' covers wind, solar, and biomass sources.

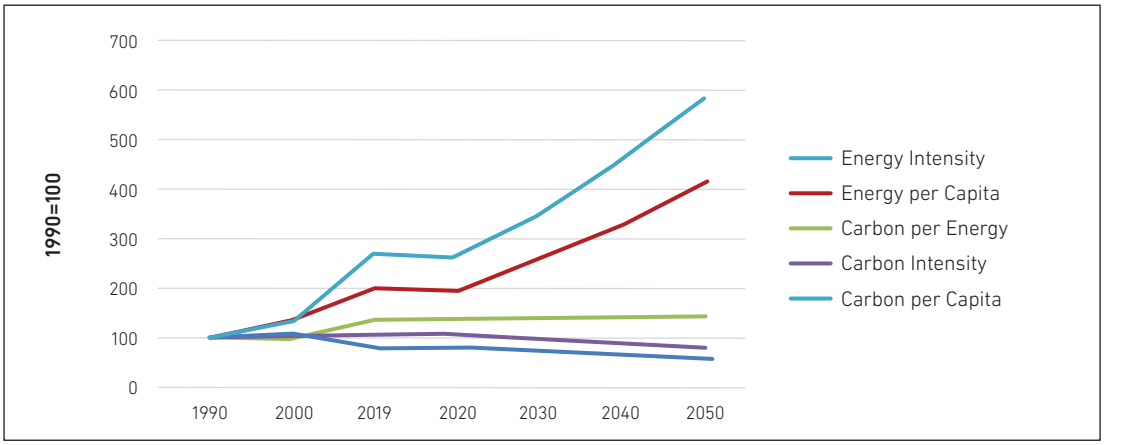
Source: Author's compilation.

The average thermal efficiency of fossil-fueled power plants in ASEAN improved from around 33% in 1990 to 35% in 2019, mainly due to more natural gas-fired power plants (especially combined cycle gas turbines) in operation. Under BAU, the thermal efficiency of fossil plants is expected to improve to around 41% by 2050. Specifically, by fuel, natural gas plants are expected to achieve a thermal efficiency of 49% in 2050, while oil and gas plants will reach 35% thermal efficiency.

2.1.4. Energy Indicators

As shown in Figure A.5, primary energy intensity, which is the ratio of primary energy supply to GDP, is expected to decrease. Energy intensity will continue to decrease as the total primary energy supply grows more slowly than the economy. The intensity of CO_2, defined as CO_2 emissions per unit of GDP, is projected to see a similar declining trend compared to energy intensity. Energy and carbon emission per capita will increase because of rapid industrialisation, lifestyle changes toward a more energy-intensive way of life, and slow population growth relative to the growth of fossil fuel demand.

Figure A.5 Energy Indicators, Business-As-Usual, 1990–2050



Source: Author's compilation.

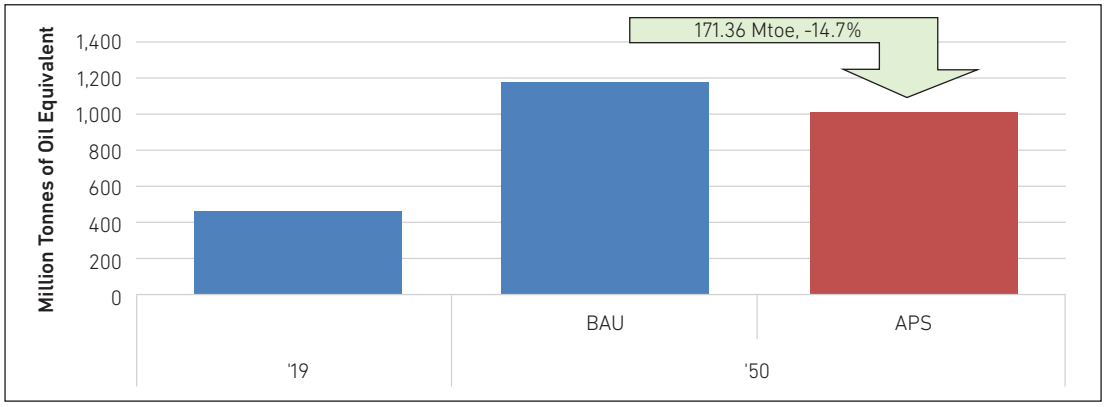
2.2 Energy Saving and Carbon Emission Reduction Potential, Alternative Policy Scenario

The APS applies the same GDP and population assumptions as the BAU. However, the APS incorporates improvements in the efficiency of final energy consumption in various end-use sectors. It also includes more efficient thermal power generation and a higher share of renewable energy in the total supply, with no nuclear power plants. By comparing the APS results with BAU, this section offers a foundation for assessing the effects of promoting energy efficiency and increasing the use of renewable energy in ASEAN. The aim is to determine the potential for energy savings and CO_2 emissions reductions within the region.

2.2.1. Final Energy Demand

Final energy demand under the APS is projected to increase by an AAGR of 2.6% from 2019 to 2050, slower than under BAU (3.1%). As shown in Figure A.6, by 2050, the total final energy demand in the APS should reach around 996 Mtoe, nearly 15% lower than under BAU. Between 2019 and 2050, the transport sector is expected to grow at an AAGR of 3.1%, followed by the industry and other sectors both at 2.5%. The AAGR of the non-energy sector is forecasted to be 1.4%, similar to BAU.

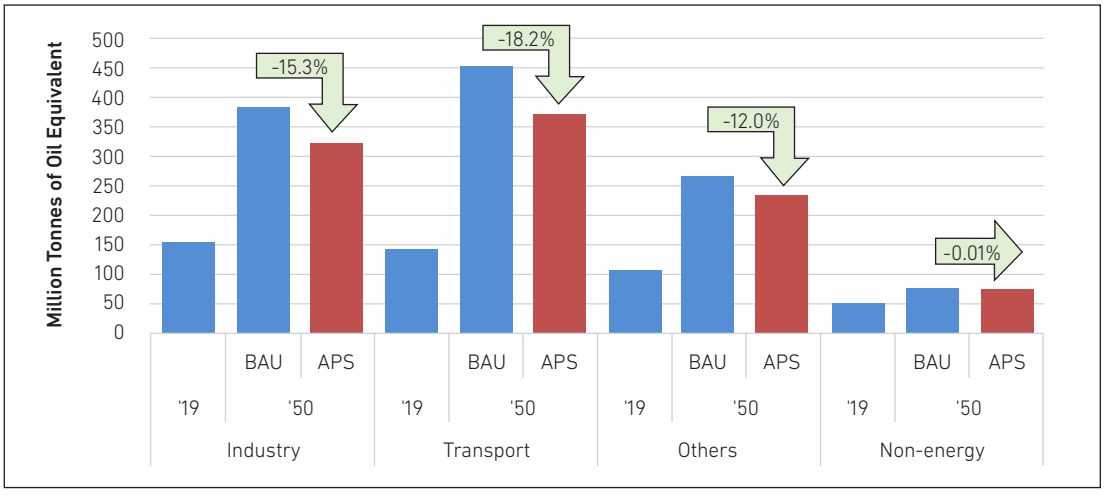
Figure A.6: Total Final Energy Demand in 2050, Business-As-Usual and Alternative Policy Scenario, 1990 and 2050
(Mtoe)



APS = alternative policy scenario, BAU = business-as-usual, Mtoe = million tonnes of oil equivalent.
Source: Author's compilation.

In the APS, the transport sector is expected to see the greatest decrease in energy consumption. Figure A.7 shows that, by 2050, the transport sector's energy consumption would decrease by over 18% in the APS, relative to BAU. Further, the industry sector is expected to have 15.3% lower energy consumption by 2050 in the APS, while the consumption in the 'other' sector would be 12% lower than under BAU.

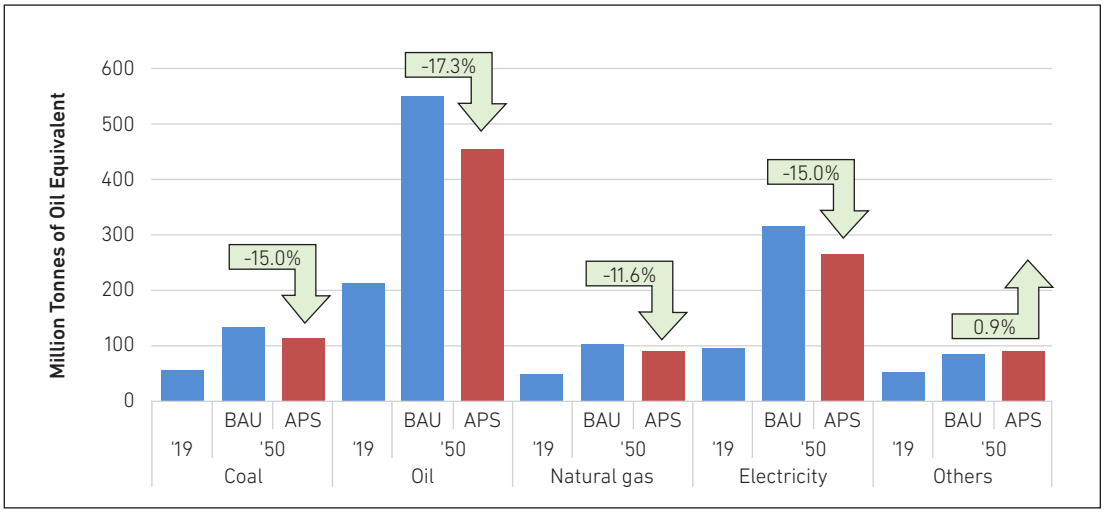
Figure A.7 Total Final Energy Demand by Sector in 2050, Business-As-Usual and Alternative Policy Scenario, 2019 and 2050
(Mtoe)



APS = alternative policy scenario, BAU = business-as-usual, Mtoe = million tonnes of oil equivalent.
Note: 'Others' covers solid and liquid biofuels.
Source: Author's compilation.

In terms of fuel type, the APS is expected to reduce oil consumption by over 17%, natural gas by over 11%, and electricity consumption by 15.7% by 2050, relative to BAU (Figure A.8). Additionally, coal demand in the APS would be 15% lower than under BAU, while consumption of 'Others' (other fuel types) would be 0.9% higher.

Figure A.8 Total Final Energy Demand by Fuel, Business-As-Usual and Alternative Policy Scenario, 2019 and 2050
(Mtoe)



APS = alternative policy scenario, BAU = business-as-usual, Mtoe = million tonnes of oil equivalent.

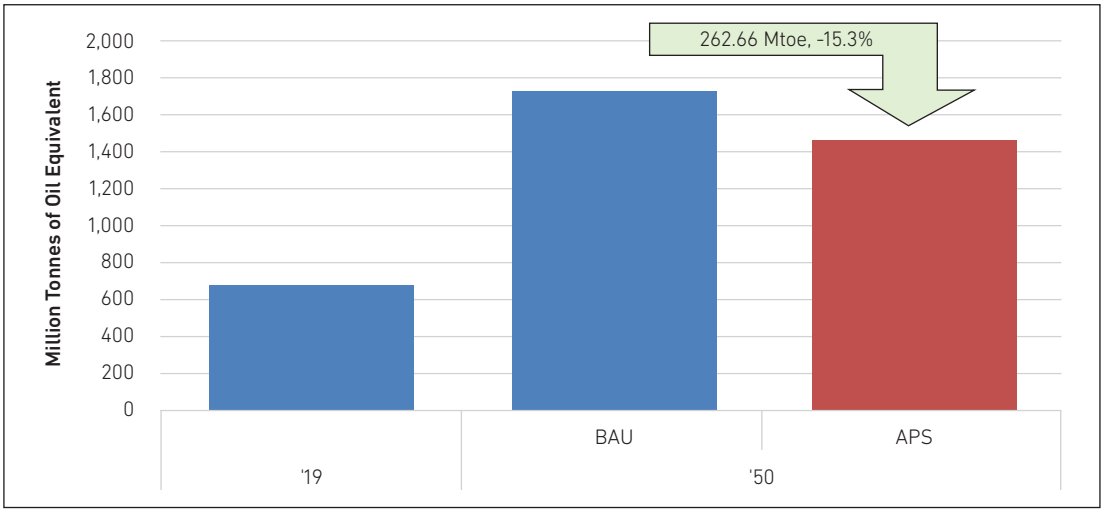
Note: 'Others' covers solid and liquid biofuels.

Source: Author's compilation from individual Association of Southeast Asian Nations member states' results.

2.2.2. Primary Energy Supply

In 2050, the APS would decrease the TPES by around 263 Mtoe, or over 15% compared to BAU (Figure A.9). Most of this reduction will come from coal at 254 Mtoe, indicating a drop of around 50% compared to BAU (Figure A.10). Natural gas consumption would decrease by 27.5%, while oil consumption would decrease by over 17%. In contrast, the APS has a notable increase in geothermal power generation as well as solar, wind, and biomass energy sources, surpassing the levels expected under BAU. Biofuel consumption will remain relatively constant. Altogether, this scenario indicates an over 86% increase in the consumption of 'others', encompassing biomass, solar, wind, ocean, biofuel, and electricity. Additionally, around 4 Mtoe of hydrogen will also appear by 2050 in the APS.

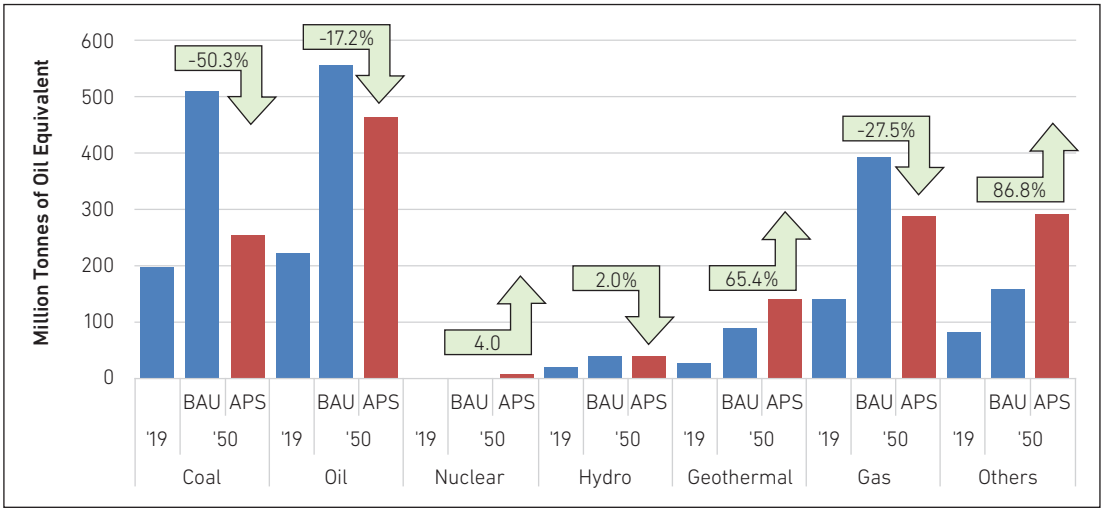
Figure A.9 Total Primary Energy Supply, Business-As-Usual and Alternative Policy Scenario, 2019 and 2050
(Mtoe)



APS = alternative policy scenario, BAU = business-as-usual, Mtoe = million tonnes of oil equivalent.

Source: Author's compilation.

Figure A.10 Total Primary Energy Supply by Fuel, Business-As-Usual and Alternative Policy Scenario, 2019 and 2050
(Mtoe)



APS = alternative policy scenario, BAU = business-as-usual, Mtoe = million tonnes of oil equivalent.

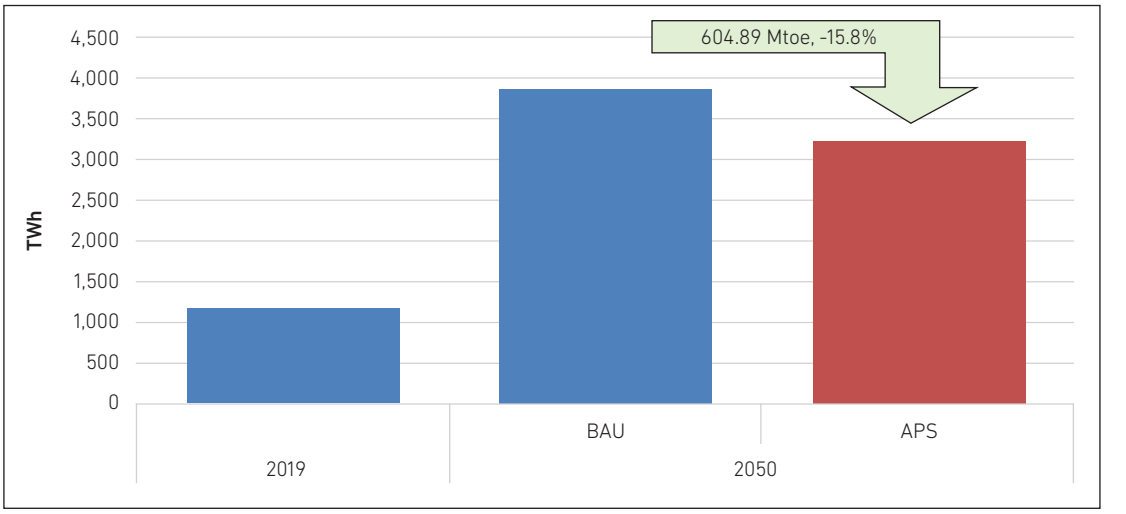
Note: 'Others' 'covers solar, wind, and solid and liquid biofuels.

Source: Author's compilation.

2.2.3. Power Generation

In the APS, electricity generation in 2050 decreased by around 605 TWh (nearly 16%) from BAU (Figure A.11). As shown in the Figure A.12, by 2050, the APS policy measures would reduce coal-fired electricity production by over 54% and gas-fired electricity production by 22% compared to BAU. Additionally, the use of 'other' energy sources (mainly solar) to generate electricity in the APS would almost triple to 734 TWh from 251 TWh under BAU. Geothermal power generation is anticipated to increase by nearly 75% from BAU to the APS. Moreover, the APS envisions that nuclear plants will contribute to the generation of a little over 15 TWh of electricity by 2050, while no nuclear based power generation is expected under BAU.

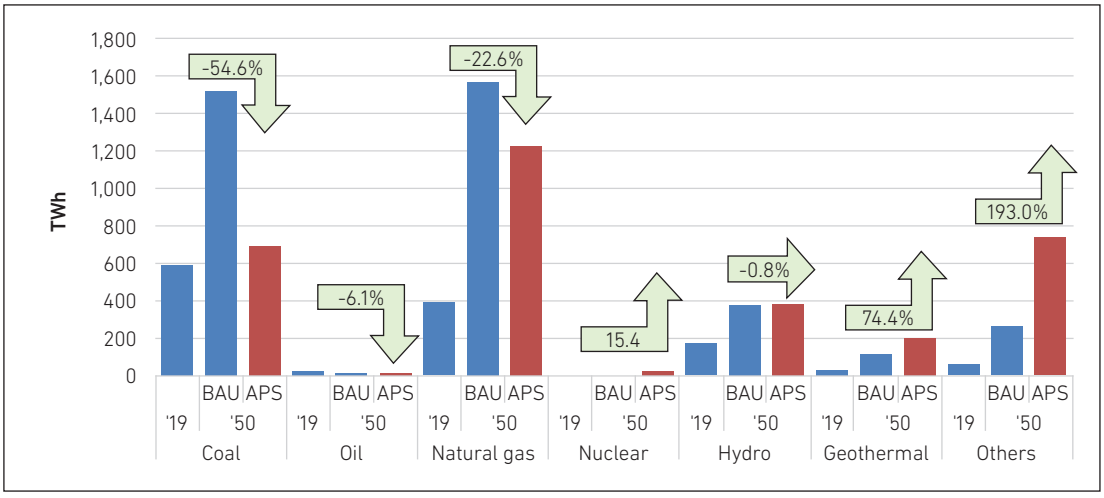
Figure A.11 Electricity Generation, Business-As-Usual and Alternative Policy Scenario, 2019 and 2050
(TWh)



APS = alternative policy scenario, BAU = business-as-usual, Mtoe = million tonnes of oil equivalent, TWh = terawatt-hour.
Source: Author's compilation.

Figure A.12 Electricity Generation by Source, Business-As-Usual and Alternative Policy Scenario, 2019 and 2050

(TWh)



APS = alternative policy scenario, BAU = business-as-usual, Hydro = hydropower, TWh = terawatt hour.

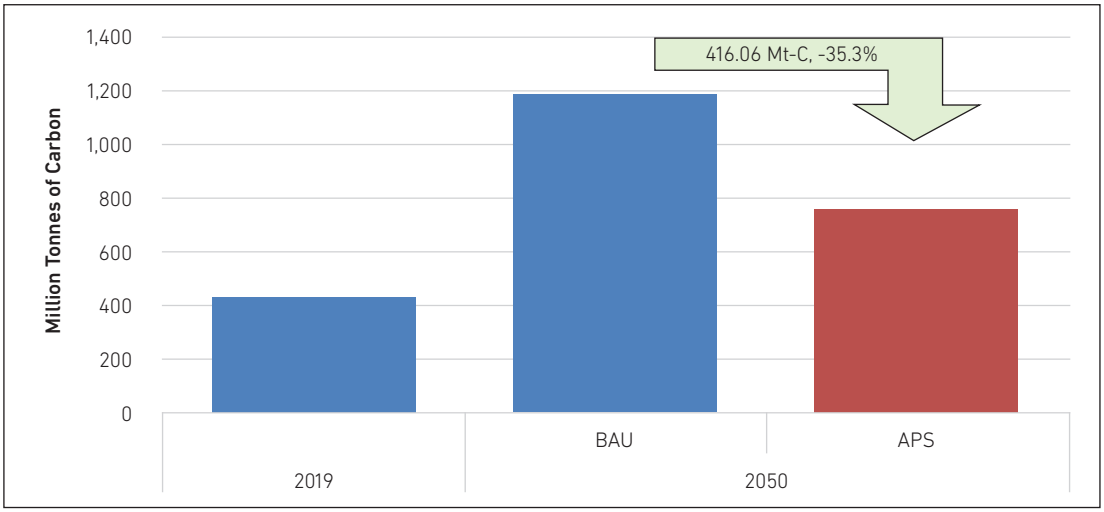
Note: 'Others' covers wind, solar, and biomass sources.

Source: Author's compilation.

2.2.4. Carbon Emission Reduction Potential

Under BAU, carbon emissions from energy demand are projected to increase at an AAGR of 3.3%. This would lead to an increase from 425 million tonnes of carbon equivalent (Mt-C) in 2019 to around 1177 Mt-C in 2050 (Figure A.13). During the same period, in the APS, emissions would grow at an AAGR of 1.9% to 761 Mt-C by 2050. Therefore, the APS demonstrates a potential for reducing CO_2 emissions by approximately 416 Mt-C by 2050, a decrease of over 35% compared to BAU.

Figure A.13 Carbon Emissions from Energy Consumption, Business-As-Usual and Alternative Policy Scenario, 2019 and 2050
(Mt-C)



APS = alternative policy scenario, BAU = business-as-usual, Mt-C = million tonnes of carbon.
Source: Authors' compilation.

2.3. Energy Saving and Carbon Emission Reduction Potential, Low Carbon energy Transition Scenario

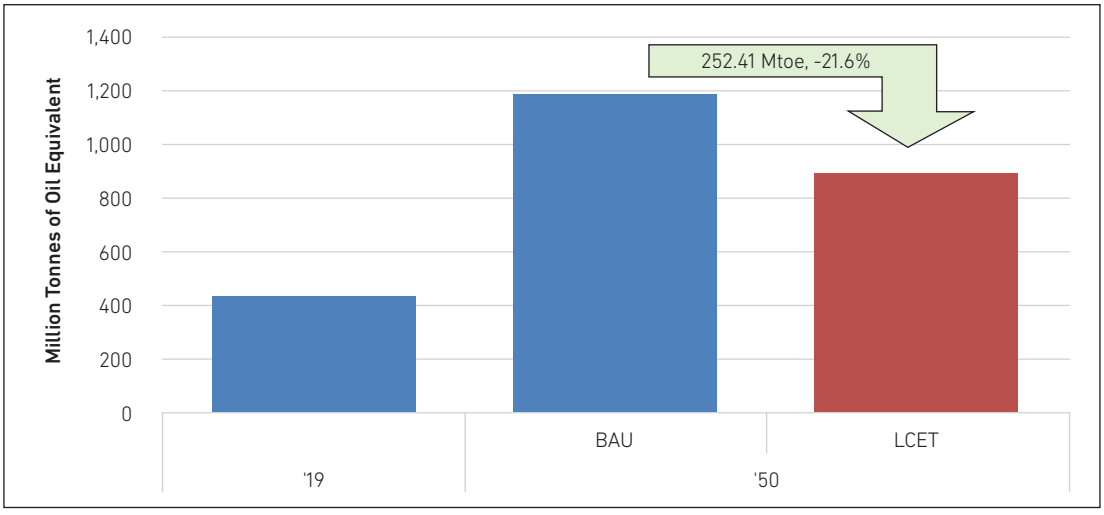
In the low carbon energy transition (LCET) scenario, the assumptions regarding GDP and population are consistent with those of the BAU and the APS. However, the LCET scenario assumes that each ASEAN member state will achieve carbon neutrality by either 2050 or 2060, depending on their individual commitments and pledges.

This section serves as a foundation for evaluating the impacts of integrating low carbon technologies and new energy resources and carriers in ASEAN. By comparing the results of the LCET scenario with BAU, it allows for the assessment of the impacts achieved by implementing these measures in addition to the assumptions made for improving final users' energy consumption and expanding the share of renewable energy sources, as already considered in the APS.

2.3.1. Final Energy Demand

Final energy demand under the LCET is projected to increase by an AAGR of 2.3% from 2019 to 2050, slower than under BAU (3.1%) and APS (2.6%). As shown in Figure A.14, by 2050, the total final energy demand in the LCET should reach around 915 Mtoe, nearly 22% lower than under BAU. Between 2019 and 2050, the transportation sector is expected to grow at an AAGR of 2.7%, followed by the industry with 2.3% and other sectors at 2.2%. The AAGR of the non-energy sector is forecast to be 1.5%, almost like BAU (1.4%).

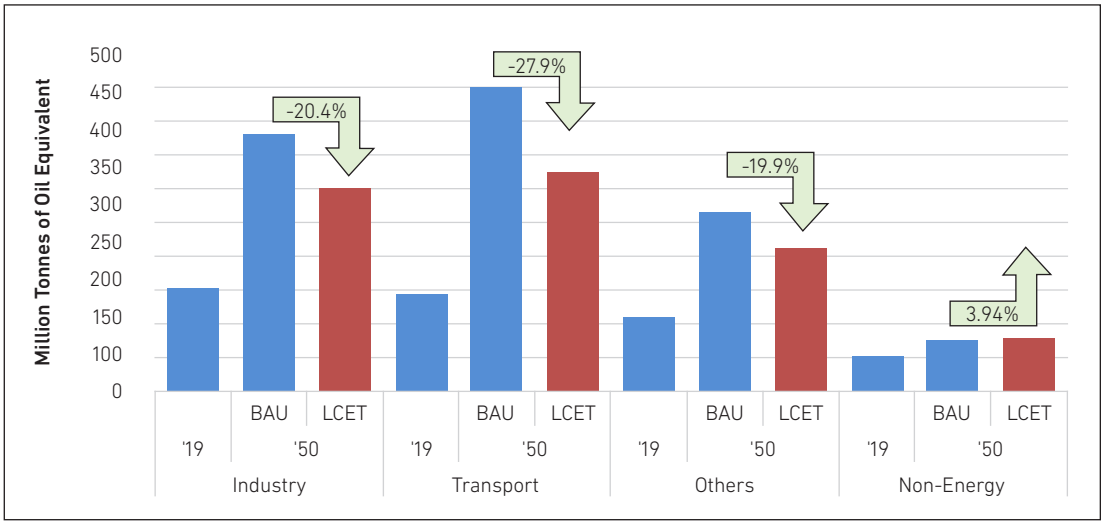
Figure A.14 Total Final Energy Demand, Business-As-Usual and Low Carbon Energy Transition, 2019 and 2050
(Mtoe)



BAU = business-as-usual, LCET = low carbon energy transition, Mtoe = million tonnes of oil equivalent.
Source: Author's compilation.

In the LCET scenario, the transport sector is expected to see the greatest decrease in energy use by 27% relative to BAU as shown in the Figure A.15. Similarly, by 2050, the energy consumption of the industry and 'Others' sectors should be around 20% lower each in the LCET compared to BAU.

Figure A.15 Total Final Energy Demand by Sector, Business-As-Usual and Low Carbon Energy Transition, 2019 and 2050
(Mtoe)



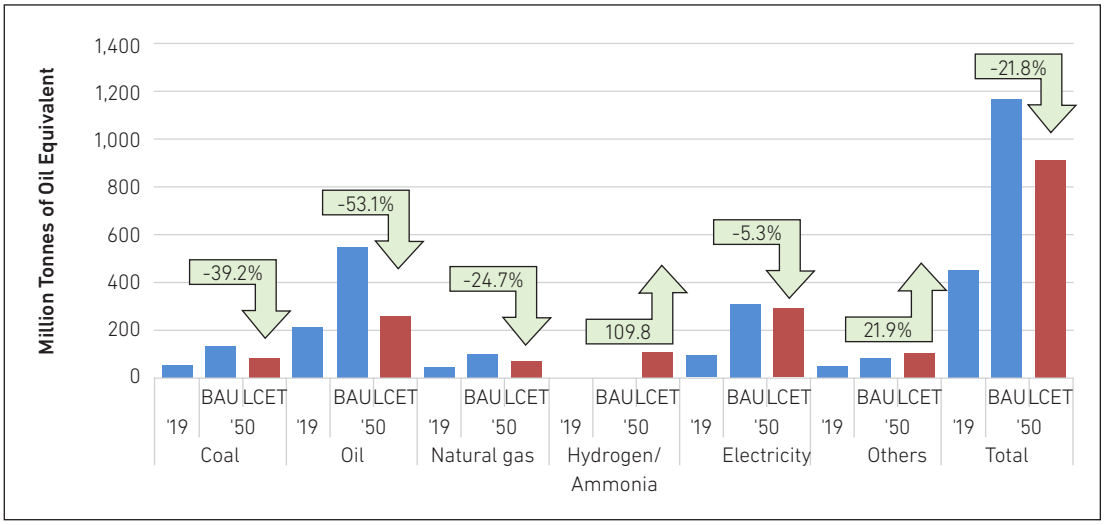
BAU = business-as-usual, LCET = low carbon energy transition, Mtoe = million tonnes of oil equivalent.

Note: 'Others' covers subsectors such as residential, agriculture, services, and commerce.

Source: Author's compilation.

By 2050, the LCET scenario is expected to achieve substantial reductions in fuel consumption compared to BAU. Specifically, in the LCET scenario, oil consumption is expected to decrease by over 53%, coal consumption by 29%, natural gas consumption by almost 25%, and electricity consumption by over 5% (Figure A.16). In the LCET scenario, the consumption of 'Others' (other fuel types) is expected to increase by nearly 22% compared to BAU. Finally, hydrogen and ammonia will be used for co-firing in gas-fired and coal-fired power plants by 2040. As a result, the total final demand for hydrogen and ammonia combined is projected to reach around 110 Mtoe by 2050 within this scenario.

Figure A.16 Total Final Energy Demand by Fuel, Business-As-Usual and Low Carbon Energy Transition, 2019 and 2050
(Mtoe)



BAU = business-as-usual, LCET = low carbon energy transition, Mtoe = million tonnes of oil equivalent.

Note: 'Others' covers solid and liquid biofuels.

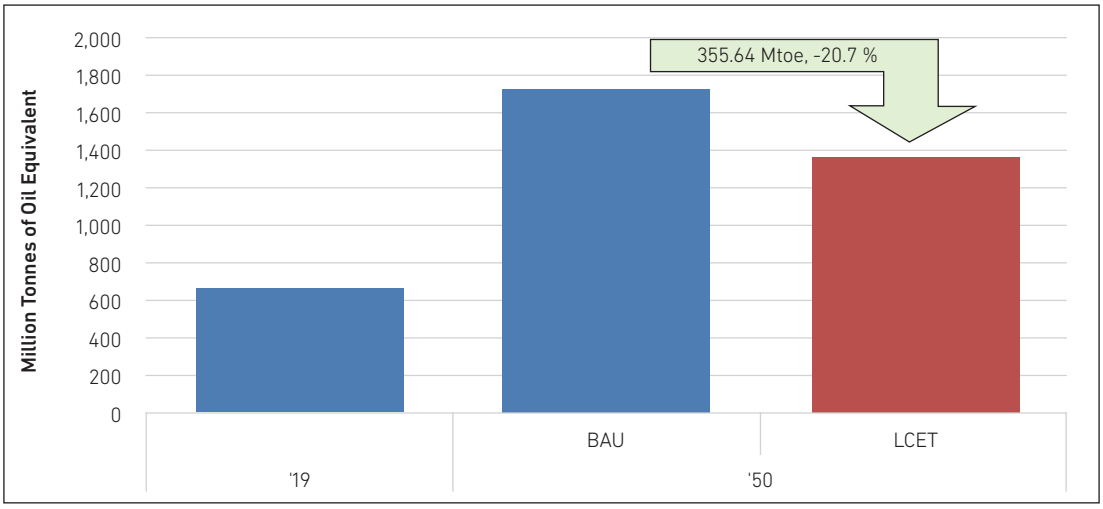
Source: Author's compilation from individual Association of Southeast Asian Nations member states' results.

2.3.2. Primary Energy Supply

In 2050, relative to BAU, measures in the LCET scenario would decrease the total primary energy supply (TPES) by around 355 Mtoe, or around 20% (Figure A.17). Most of this reduction will come from coal at 320 Mtoe, a drop of around 63% from BAU (Figure A.18). Natural gas would decrease by 30%, and oil consumption would decrease by over 53%. In the LCET scenario, geothermal power generation will increase by 43% compared to BAU. Other fuels' consumption such as solar, wind, ocean, and biomass would more than double, from 154 Mtoe in BAU to 321.

Figure A.17 Total Primary Energy Supply, Business-As-Usual and Low Carbon Energy Transition, 2019 and 2050

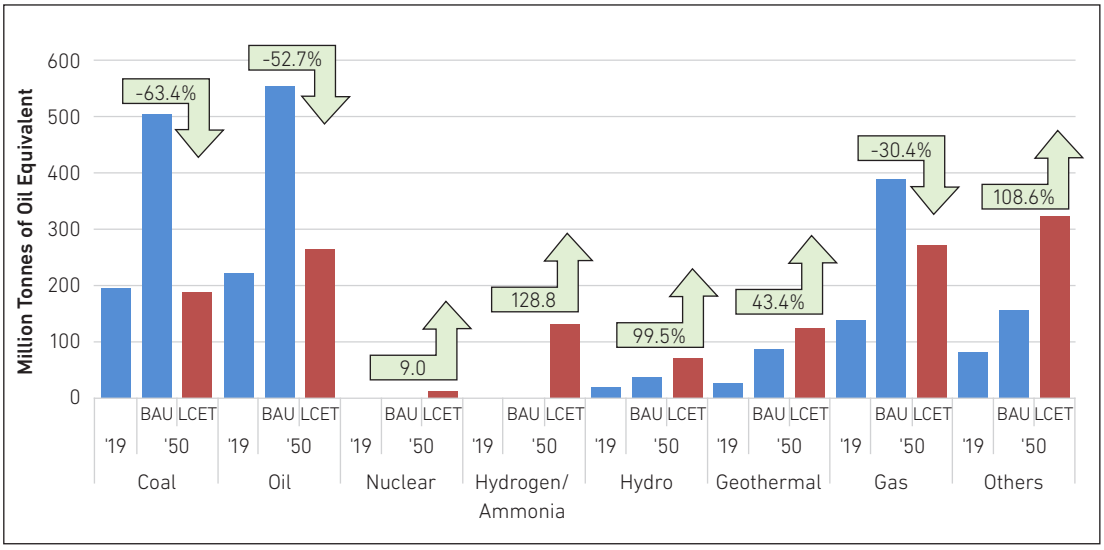
(Mtoe)



BAU = business-as-usual, LCET = low carbon energy transition, Mtoe = million tonnes of oil equivalent.

Source: Author's compilation.

Figure A.18 Total Primary Energy Supply by Fuel, Business-As-Usual and Low Carbon Energy Transition, 2019 and 2050



BAU = business-as-usual, LCET = low carbon energy transition, Mtoe = million tonnes of oil equivalent.

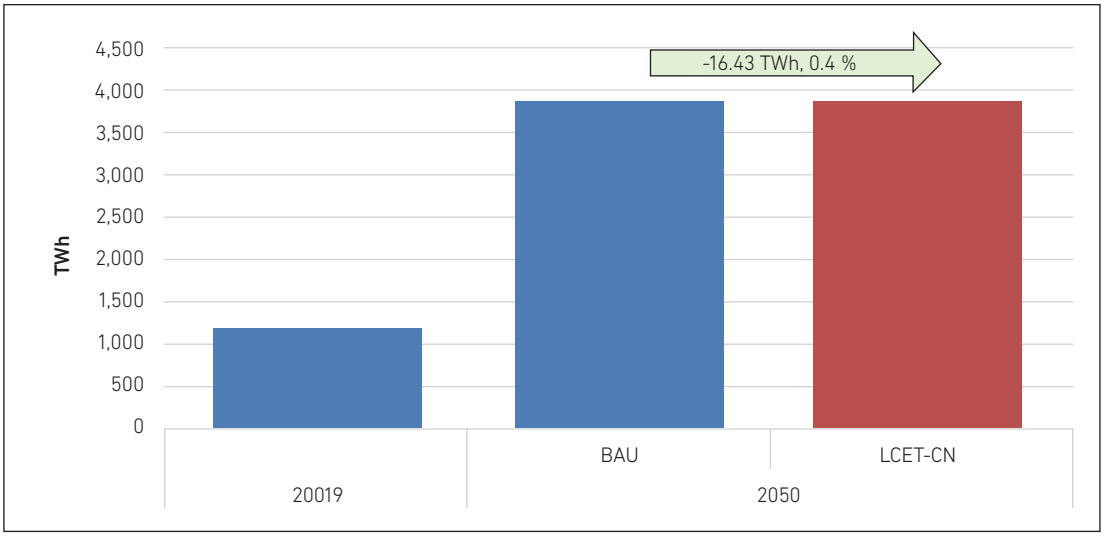
Note: 'Others' covers solar, wind, and solid and liquid biofuels.

Source: Author's compilation.

2.3.3. Power Generation

In the LCET scenario, electricity generation in 2050 would reach around 3,848 TWh, which is only a 0.4% (16 TWh) increase from 3,832 TWh in BAU (Figure A.19). Strong electrification measures in transport are amongst the most important factors that boost power generation in the LCET scenario.

Figure A.19 Electricity Generation, Business-As-Usual and Low Carbon Energy Transition, 2019 and 2050
(TWh)

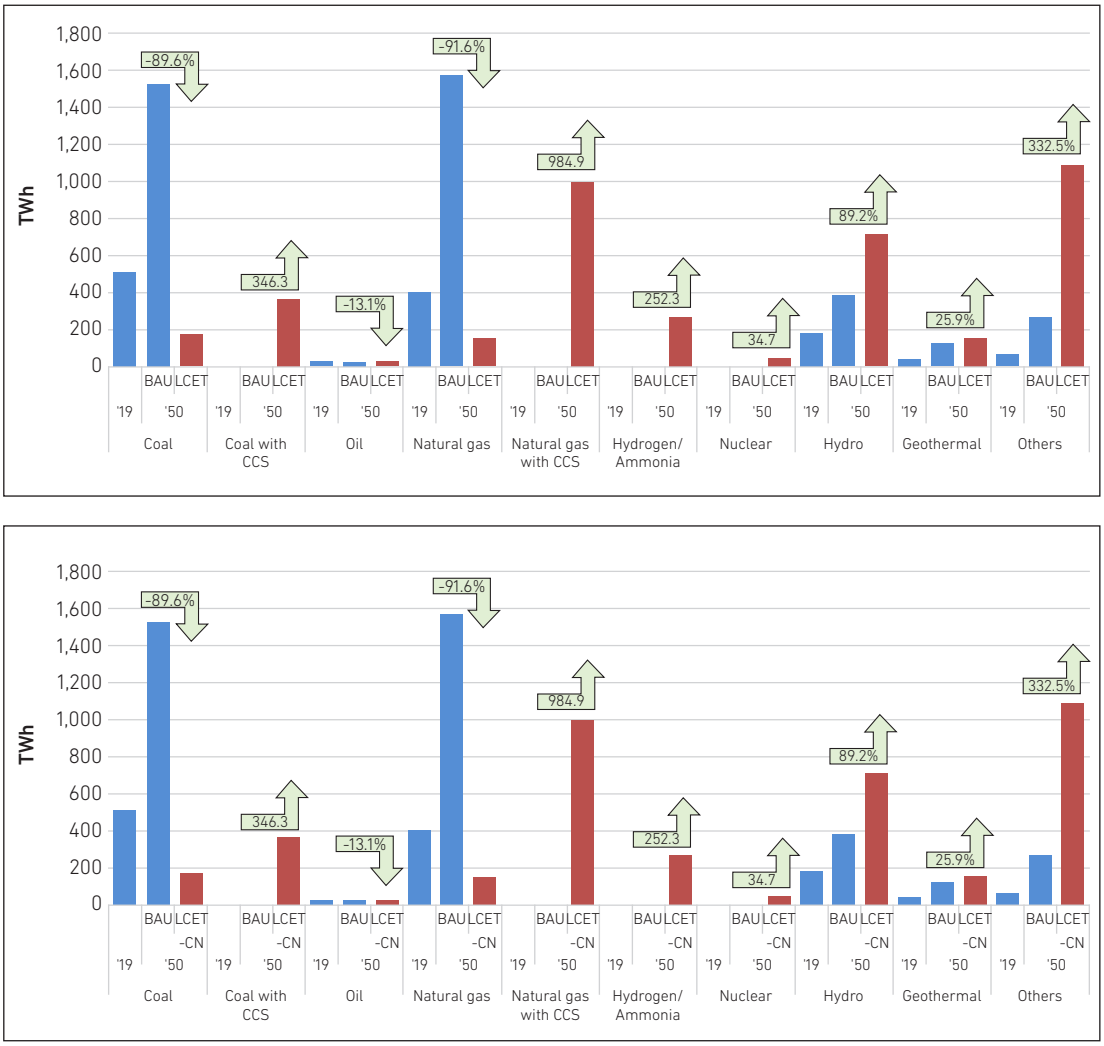


BAU = business-as-usual, LCET = low carbon energy transition, Mtoe = million tonnes of oil equivalent, TWh = terawatt-hour.
Source: Author's compilation.

As shown in Figure A.20, by 2050, the policy measures in the LCET should reduce the production of coal-fired electricity by nearly 90% (1,360 TWh) and that of gas-fired electricity production by almost 92% (1,433 TWh) from BAU. Use of 'other' energy sources (mainly solar) to generate electricity in the APS would almost triple to 734 TWh from 251 TWh under BAU. In LCET, coal-fired power production combined with carbon capture and sequestration (CCS) is assumed to appear by 2030 and by 2050 and reach 346 TWh of electricity production. Gas-fired power production combined with CCS is assumed to enter the market by 2019. By 2050, this combination produces 985 TWh of power. The gradual utilisation of hydrogen and/or ammonia in co-firing, specifically with natural gas and coal in power generation, is assumed to appear gradually by 2020. By 2050, it is anticipated that the total electricity produced through this method would reach around 252 TWh. Nuclear power plants are assumed to start power production by 2040 in this LCET scenario. By 2050, the total power produced would reach 35 TWh. Also, by 2050, electricity generated by hydro power plants in the LCET scenario would increase by 89% compared to BAU, whilst that of geothermal plants would increase by nearly 26% from BAU to the LCET.

Finally, power generation in 2050 from other sources, i.e. solar, wind, and biomass, would increase by 4.3 times from 251 TWh in BAU to 1084 TWh in the LCET scenario.

Figure A.20 Electricity Generation by Source, Business-As-Usual and Low Carbon Energy Transition, 2019 and 2050
(TWh)



BAU = business-as-usual, Hydro = hydropower, LCET = low carbon energy transition, TWh = terawatt hour.

Note: 'Others' covers wind, solar, and biomass sources.

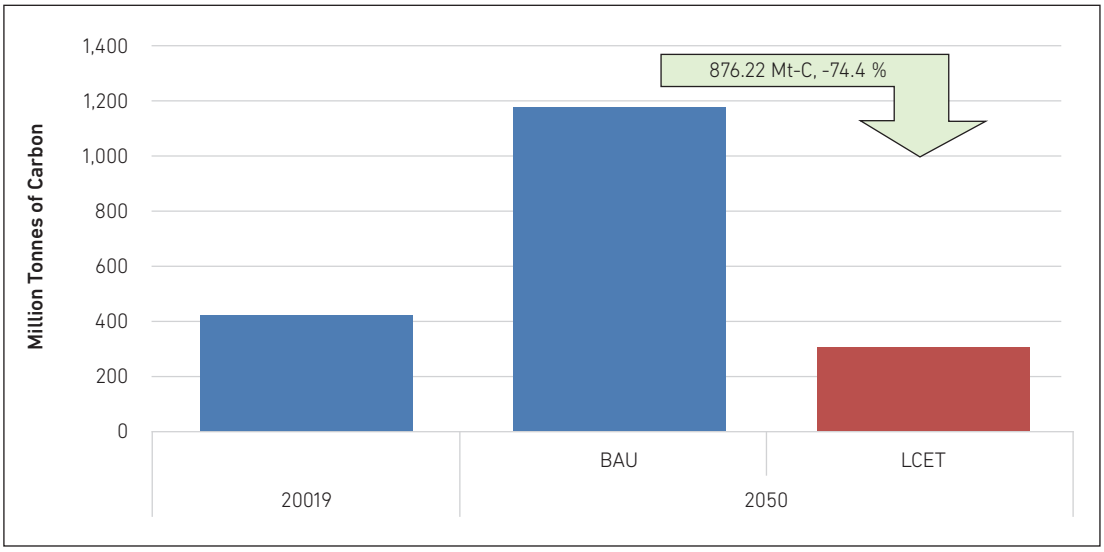
Source: Author's compilation.

2.3.4. Carbon Reduction Potential

Under BAU, carbon emissions from energy demand are projected to increase at an AAGR of 3.3%, from 425 million tonnes of carbon (Mt-C) in 2019 to around 1,177 Mt-C in 2050 (Figure A.21). During the same period, in the LCET, emissions would decrease by 1.1% to 301 Mt-C by 2050. In other words, CO_2 emissions in the LCET scenario in 2050 (301 Mt-C) are around 29% less than 2019' CO_2 emissions (425 Mt-C).

The LCET scenario has the potential to significantly reduce CO_2 emissions, leading to a savings of around 876 Mt-C by 2050. This represents a decrease of over 74% compared to BAU. The emissions reduction achieved in the LCET scenario of 876 Mt-C by 2050 is more than double the amount saved in the APS, which is 416 Mt-C.

Figure A.21 Carbon Emissions from Energy Consumption, Business-As-Usual and Alternative Policy Scenario, 2019 and 2050
(Mt-C)



APS = alternative policy scenario, BAU = business-as-usual, LCET = low carbon energy transition, Mt-C = million tonnes of carbon.
Source: Author's compilation.

3. Implications and Policy Recommendations

At least five main conclusions can be derived based on the outlook results. First, energy consumption in ASEAN, in BAU is projected to increase continuously as a result of stable economic growth up to 2050. Second, individual governments of ASEAN member states have been implementing diversified sector measures to promote and advocate the adoption of clean energy technologies and sources, as well as emissions reduction. If, by implementing those measures, member states could accomplish their energy efficiency and renewable energy penetration targets over the next 3 decades, as in the APS scenario, then ASEAN as a region would reduce energy consumption and carbon emissions significantly. Third, achieving carbon neutrality in member states would require not only aggressive implementation of energy efficiency and conservation (EEC) and the expansion of renewable energy (RE), but also the implementation of new low carbon technologies. These technologies include such as CCUS/CCS in power generation and industry, high efficiency combined cycle gas turbines (CCGT), and the introduction of new energy carriers and sources such as hydrogen and ammonia for co-firing in natural gas and/or coal fired power plants and various industries.

Electrification in the different final sectors is the key measure considered in the LCET scenario, including mobility. In mobility, for example, the use of diesel and gasoline fuel in public transport will be replaced by electric power. It is expected that by 2035, some countries will completely run their buses on electricity. Between 2025 and 2050, private passenger transport modes will undergo a process of electrification with some countries be reaching the share of 70% of electric vehicles amongst their private modes.

The successful implementation of low carbon-fuel switching technology, energy sources, and carriers, as in the LCET scenario, would lead to a level of carbon emissions in 2050 lower than the level of carbon emissions in 2019.

Fourth, at the regional level, ASEAN must put forward more initiatives and programmes, to improve energy efficiency and boost renewable energy share by speeding up regional collaboration and international cooperation.

Fifth, energy efficiency promotion measures in transport fuel and electricity generation will be essential. The affordable and stable use of renewable energy will also be crucial. To promote the use of renewable energy, the parallel use of affordable natural gas will be key. A liquefied natural gas hub in Asia is one option to secure a stable and affordable natural gas supply for ASEAN.

As the fifth largest economy in the world currently, ASEAN plays an important role in terms of energy consumption and greenhouse gas emissions. Continuously monitoring and observing energy savings and emissions reductions at the ASEAN level, along with regular updates to the regional energy outlook, as presented in this chapter, are therefore crucial.

References

International Monetary Fund (2022), *Regional Economic Outlook: Asia and Pacific–Sailing into Headwinds, October 2022*. Washington, DC: International Monetary Fund.

The World Bank (2023), World Development Indicators. https://data.worldbank.org/indicator/NY.GDP.MKTP.KD (accessed 6 January 2022).